2.2.2.4 Big Lost River Tributary Basin. The Big Lost River upstream from Arco drains a mountainous 3,652-km^2 (1,410-mi^2) tributary basin that includes the Lost River Range and Pioneer Mountains to the west of the ESRP (Figure 2-16). This basin ranges in altitude from about 1,615 m (5,300 ft) above sea level near Arco to more than 3,840 m (12,600 ft) above sea level in the Lost River Range. Mean elevation is approximately 2,347 m (7,700 ft).

Water derived from the Big Lost River watershed moves as streamflow down the Big Lost River and its tributaries or infiltrates alluvial deposits and moves downgradient as groundwater flow through alluvium-filled basins between the mountain ranges. Streamflows and tributary underflow provide sources of recharge to the SRPA.

Recharge to the SRPA from Infiltration of Streamflow in the Big Lost River—Recharge to the SRPA from infiltration of streamflow along the channel of the Big Lost River occurs in proximity to several major facilities and contaminant source terms at the INL Site. Because of this proximity, this source of recharge is critical to an evaluation of contaminant transport in the SRPA.

The Big Lost River flows to the southeast from its tributary drainage system onto the ESRP. Shortly after entering the ESRP, the stream channel is diverted to the east (Figure 2-16) by the topographically high vent areas associated with the Arco Rift. The Big Lost River channel continues to the east and then to the north, cutting a canyon through basalt flows in the southwestern part of the INL Site and flowing onto a broad floodplain that extends from near the RWMC north to a series of playa lakes. In the 1960s, a diversion channel was constructed to a series of low-lying areas south of the river to divert excess flows for downstream floodwater protection.

Streamflows in the Big Lost River are controlled by snowpack, storage in Mackay Reservoir, and downstream irrigation. Streamflows are monitored at a series of stream gaging stations operated by the USGS (USGS 2005). The average annual discharge for the Big Lost River near Arco for 48 years of streamflow data (1947 though 1960, 1967 through 1979, and 1983 through 2003) is shown in Figure 2-17. Based on this period of record, average annual discharge is variable, ranging from 488 cfs in 1984 to zero during several years. The average annual discharge for the period of record is 97.3 cfs (70,225 acre-ft/year).

Episodic recharge occurs in response to these variable streamflows as they rapidly infiltrate through the Big Lost River channel and in the INL Site spreading areas (Figure 2-2). Streamflow records measured from 1985 through 2003 at a series of stream gaging stations downstream from the Arco gage were used to estimate the percentage of water that infiltrated along specified reaches during that period. Streamflows and average infiltration estimates are shown in Table 2-3. These estimates were made assuming that recharge was rapid and evapotranspiration losses were minimal. Based on these data, as much as 14.5% (or approximately 14 cfs) of the Arco streamflows infiltrated in the reach extending from the Arco gage to a gaging station at the spreading area diversion channel, and 25.9% (or approximately 25 cfs) of the streamflows were diverted for recharge in the INL Site spreading areas. A total of 12.6% (or approximately 12 cfs) of the Arco streamflows infiltrated in the stream reach from the spreading-area diversion to Lincoln Boulevard. A total of 47% (or approximately 46 cfs) of the Arco streamflow was available for infiltration in the stream reach from Lincoln Boulevard to the Big Lost River sinks and playa to the north. These recharge estimates do not reflect the large range in discharge that occurs from year to year. They also do not take into account losses derived from evapotranspiration in the channel and streambank, diversions, and playas.

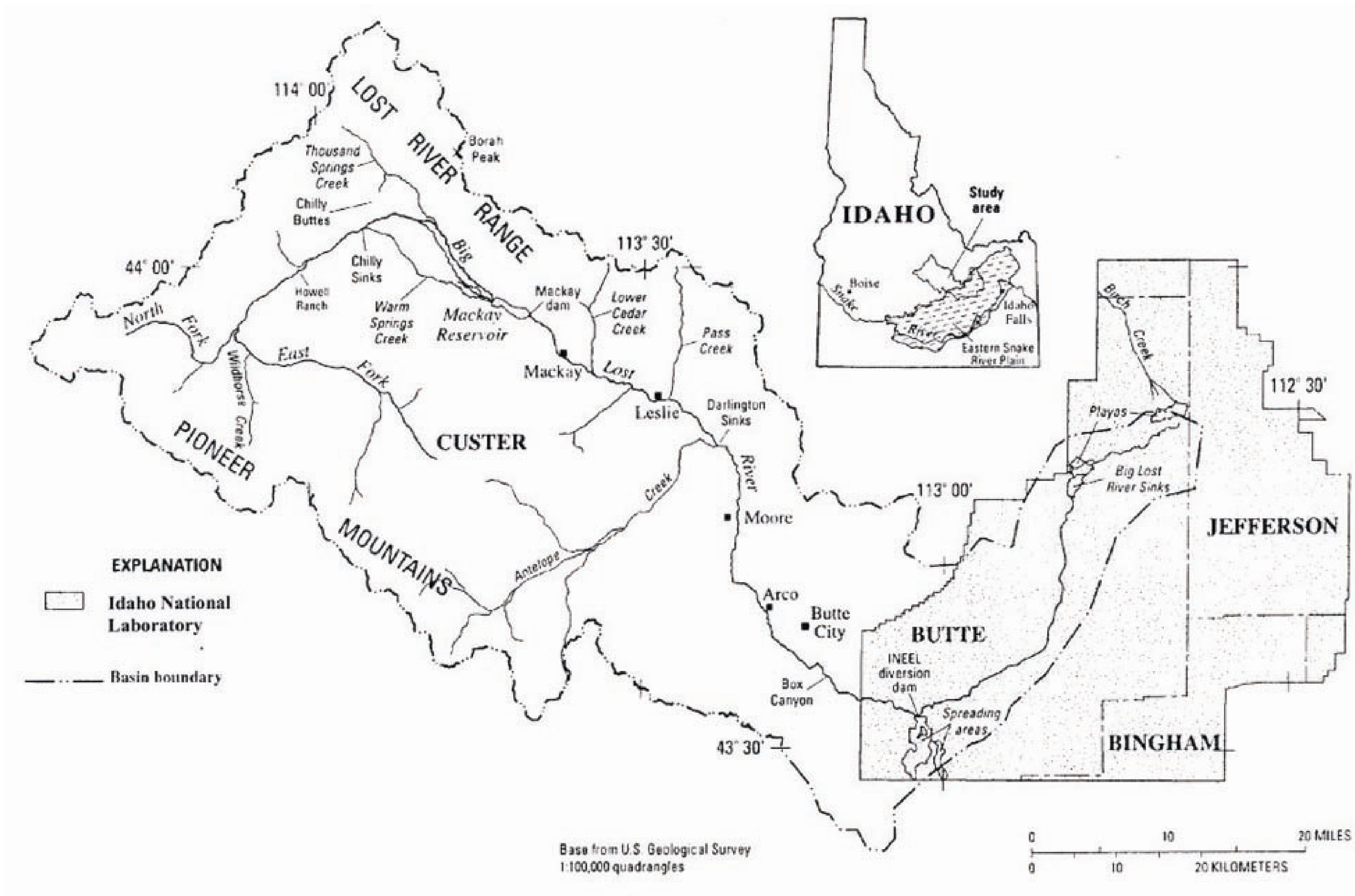

Figure 2-16. Big Lost River tributary drainage basin (modified from Hortness and Rousseau 2003.)

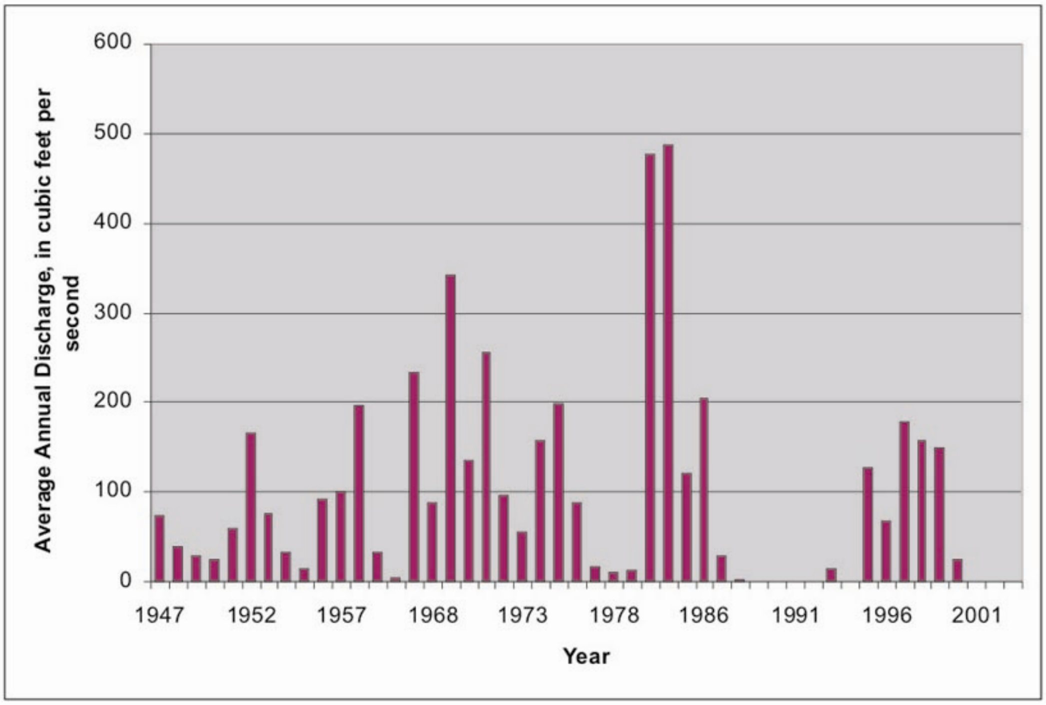

Figure 2-17. Average annual discharge for the Big Lost River near Arco from 1947 through 2003.

Table 2-3. Average annual discharge and estimated infiltration for the Big Lost River from Arco to the terminus (1985 through 2003).

Year	Average Discharge, Big Lost River near Arco (cfs)[a]	Flow Diverted to the INL Site Spreading Areas (cfs)[a]	Average Discharge in the Big Lost River near Arco minus flow to INL Site Spreading Areas	Average Discharge, Big Lost River below INL Site Spreading Areas (cfs)[a]	Estimated Infiltration Losses, Big Lost River near Arco to the INL Site Spreading Area Diversion (cfs)	Average Discharge, Big Lost River at Lincoln Boulevard (cfs)[a]	Estimated Infiltration Losses, INL Site Spreading Area Diversion to Big Lost River at Lincoln Boulevard (cfs)	Estimated Infiltration Losses, Big Lost River at Lincoln Boulevard to Playas (cfs)
1985	121	39.3	81.7	60.7	21	49.1	11..6	49.1
1986	205	59	146	122	24	99.8	22.2	99.8
1987	29.2	10.3	18.9	7.1	11.8	1.41	5.69	1.41
1988	2.91	0	2.91	0	2.91	0	0	0
1989	0	0	0	0	0	0	0	0
1990	0	0	0	0		0	0	0
1991	0	0	0	0	0	0	0	0
1992	0	0	0	0	0	0	0	0
1993	14.7	0.22	14.48	10.5	3.98	7.05	3.45	7.05
1994	0	0	0	0	0	0	0	0
1995	126	50.1	75.9	63.6	12.3	54.3	9.3	54.3
1996	67.3	4.52	62.78	42.4	20.38	36	6.4	36
1997	179	52.6	126.4	102	24.4	81.9	20.1	81.9
1998	157	32.1	124.9	108	16.9	88.2	19.8	88.2
1999	150	30.8	119.2	109	10.2	78.9	30.1	78.9
2000	24.3	0	24.3	16.2	8.1	8.69	7.51	8.69
2001	0	0	0	0	0	0	0	0
2002	0	0	0	0	0	0	0	0
2003	0	0	0	0	0	0	0	0
Sum of Average Annual Discharges	1,076	279			156	505	136	505
% of Arco Flows Available for Infiltration in a Specified Reach		25.9			14.5		12.6	47.0

a. From USGS (2005).

Water infiltrating the channel of the Big Lost River must move through a thick sequence of unsaturated basalts and interbedded sediments, with a vadose zone ranging from nearly 152 m (500 ft) near the RWMC to approximately 60 m (200 ft) near the playas. Water levels in shallow, vadose-zone wells located as much as 0.8 km (0.5 mi) away from the river channel have been observed to change rapidly in response to streamflows, indicating that infiltrating water spreads away from the channel in the shallow subsurface, and that the effective area of recharge might be much wider than the narrow river channel.

Recharge to the SRPA from Underflow within Big Lost River Tributary Basin Alluvial Deposits—Groundwater within the alluvial deposits of the Big Lost River and tributary valleys flows downgradient and eventually moves into the basalts and sediments of the ESRP in the vicinity of Arco. A series of USGS studies provided estimates of the magnitude of this groundwater influx. Kjelstrom (1986) used basin-yield equations to calculate an average annual rate of groundwater flow of 408 cfs (295,379 acre-ft/year) through these alluvial deposits. Garabedian (1992) used this underflow rate as a source of groundwater inflow to the SRPA. Although the annual flux might vary somewhat in response to climatologic changes and local groundwater usage, variability is probably minimal in comparison to episodic streamflow.

Groundwater levels in the Big Lost River alluvial aquifer typically are hundreds of feet higher than those in the SRPA to the east. A transition zone between groundwater flow in the Big Lost River basin and the SRPA occurs in the vicinity of Arco. This transition zone is characterized by decreasing head with depth, as observed in the drilling of several deep wells.

Within this transition zone, water moving out from the mouth of the Big Lost River Valley remains perched on sediments or, in some instances, on massive basalts, leaking slowly through those perching units and forming a sequence of perched water zones down to the water table. Recharge occurs to the top of the aquifer throughout the entire transition area.

Description and Location of Transition Zone Geohydrologic Features—Three mountain streams flow roughly southward onto the ESRP from the northernmost portion of the B&R Province: the Big Lost River, the Little Lost River, and Birch Creek (Figure 2-1). Though some studies have referred to these transition zones (e.g., Crosthwaite et al. 1970; Koslow 1984; Mundorff et al. 1964), the stratigraphic transitions from the B&R to the ESRP have not been studied before together or in detail. The OU 10-08 groundwater modeling work plan (DOE-ID 2004) identified this as a data gap. Subsequent subsections briefly outline the results of this effort. The Big Lost River is used as an example of how the stratigraphy and hydrostratigraphy of the transitions work, because it is the most complex of the three transition zones, whereas the other two transitions are essentially simplifications of the former.

The Big Lost River exits the B&R and flows onto the ESRP at Arco (see Figure 2-18). Between 1 and 2 Ma, the Big Lost River was trapped by the rise of the AVH, which prevented flow southward toward the ancestral Snake River. There is evidence that the Big Lost River once flowed to the southwest but was cut off from this route by the rise of the Great Rift and its predecessors that were active between 480 ka and 57 ka (dates from Kuntz et al. 2002). The river's buried paleo-channels to the east were shifted and occasionally blocked by the rise of Arco Rift and Quaking Aspen Butte Rift volcanoes. During the latest Pleistocene, the eruption of the Arco flow, a typical ESRP low-angle shield volcano, pushed the Big Lost River to the east, shifting it from a more southerly previous channel. Thick sequences of buried fluvial sediments both north and south of Box Canyon as well as east and west of the Arco flow suggest that the Big Lost River migrated extensively before Box Canyon was formed. Because of the widespread distribution of subsurface fluvium, it is possible that the shift of the river by the Arco flow preceded the down cutting of Box Canyon. These successive entrapment events led to intervals where

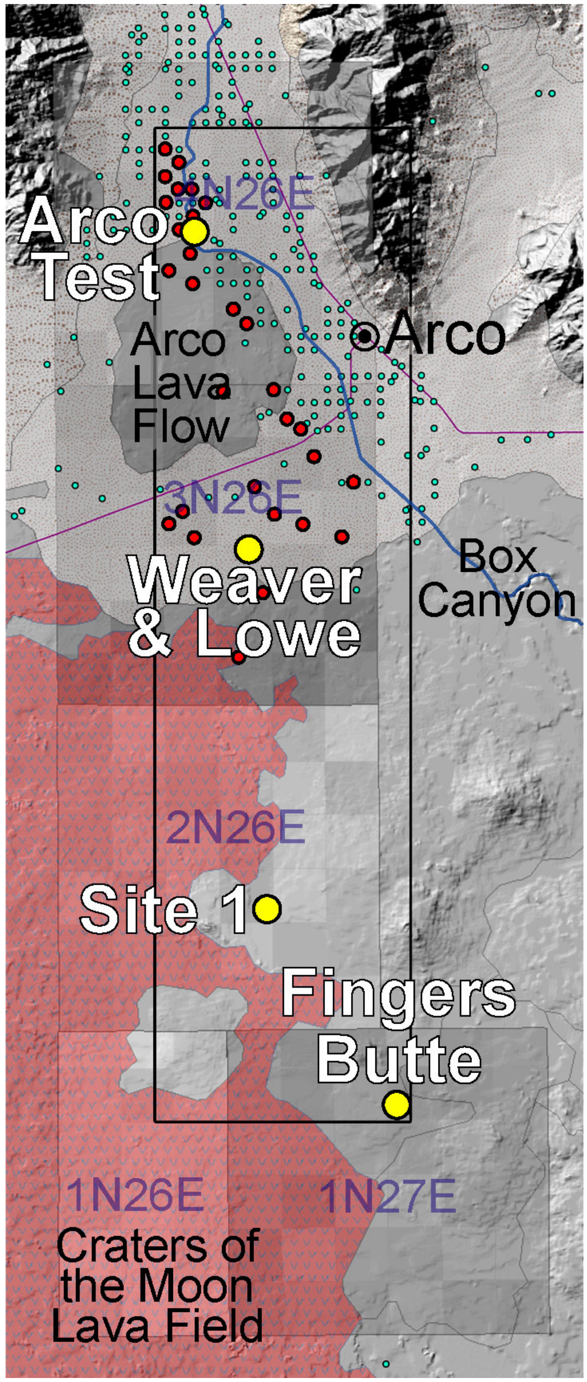

Figure 2-18. Shaded relief map of the Arco area where the Big Lost River (blue line, upper right-hand corner) exits the B&R Province and flows onto the ESRP. Major roads are in purple. Green dots are domestic water wells listed in the Idaho Department of Water Resources database. Red dots are domestic water wells whose data was used to make the cross sections shown in Figure 2-19. Yellow dots are deep wells whose data was also used to make the Figure 2 19 cross sections, for which historical water-level measurements are available. The red area is the eastern edge of the Craters of the Moon Lava Field. The black box outlines the top of the cross section boxes shown in Figure 2 19 and represents an area 18 mi long and 5 mi wide. Areas with small squares of grey shading are sections within the township-range blocks denoted by blue labels.

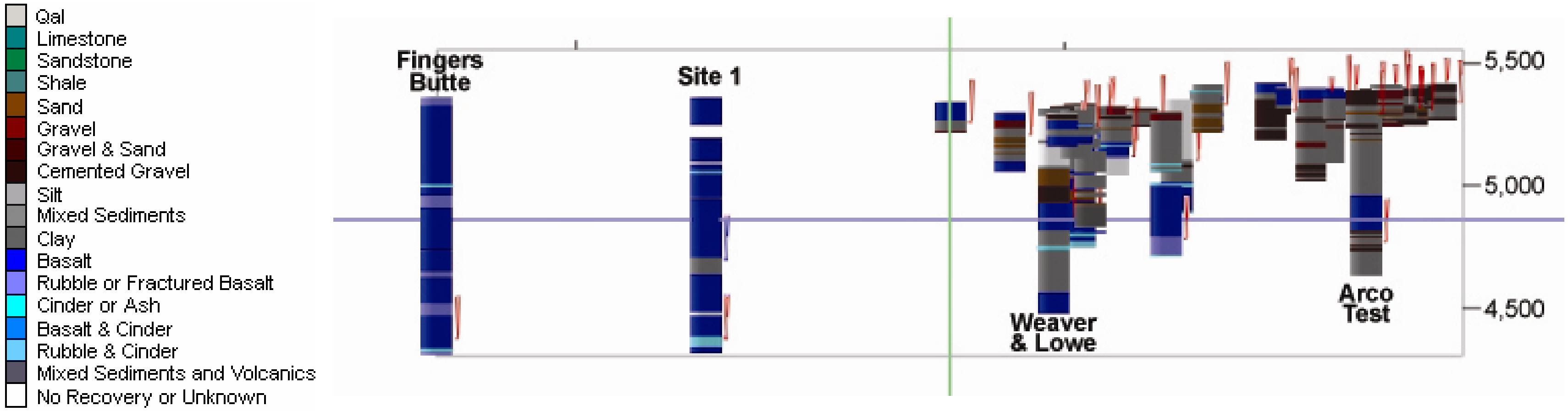

Figure 2-19a. A view from the east at a three-dimensional, 1-to-25 scale cross section of the Arco transition. This view is not tilted, so the top of the cross section box is not visible. North is to the right, and south is to the left. This view of the cross section box is 18 mi long. Elevations in feet with respect to mean sea level are shown on the right. Volcanic rocks are shown in shades of blue. Relatively permeable sediments are shown in shades of brown. Relatively impermeable sediments are shown in shades of gray. Lithified sedimentary rocks are in shades of green. The red triangular symbols are recorded static water tables. Blue symbols are either water table measurements after a well was deepened (for wells in the right half of figure) or a perched layer (for wells in the left half of figure).

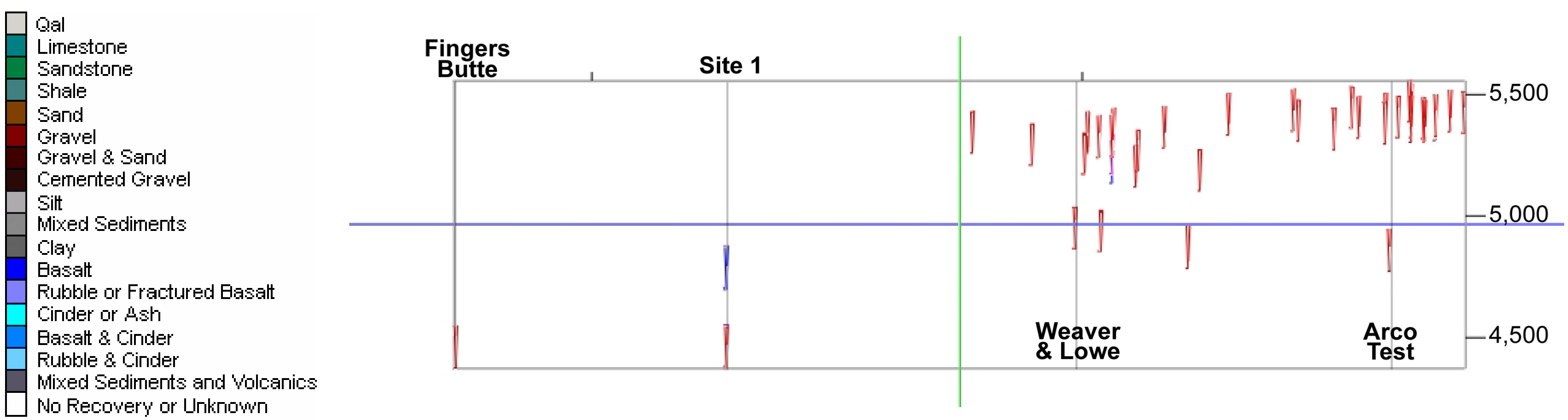

Figure 2-19b. Same as Figure 2-19a without lithology (water levels only).

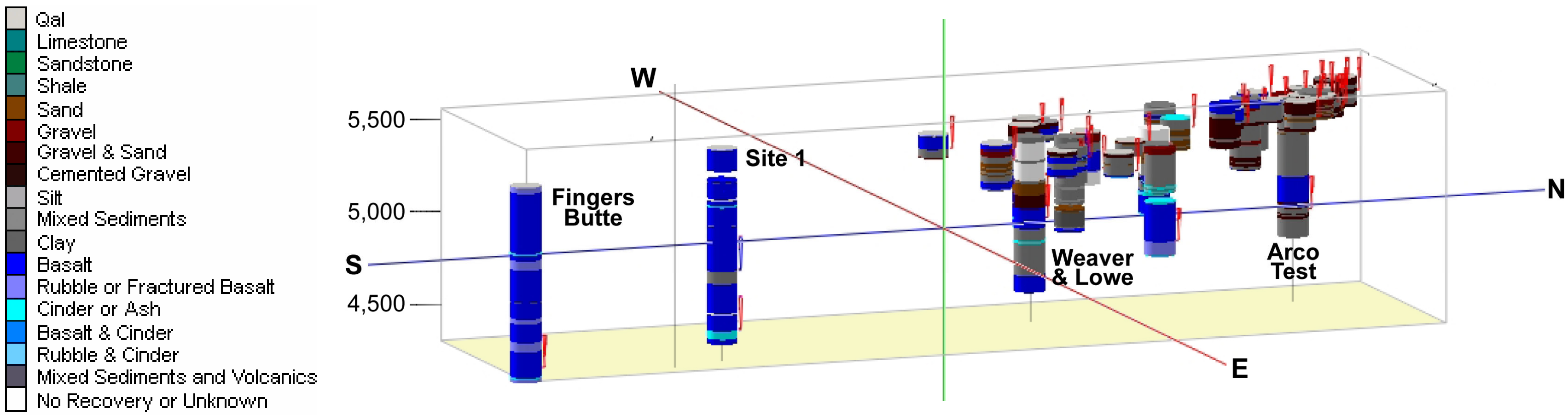

Figure 2-19c. A view at an angle of 10° above horizontal from the southeast (at an azimuthal bearing of 110°) of a 1-to-20 scale, three-dimensional cross section of the Arco transition. The cross section box represents an area 18 mi long and 5 mi wide. Elevations are in feet are with respect to MSL. All other cross section information is the same as that already described for Figure 2-19a.

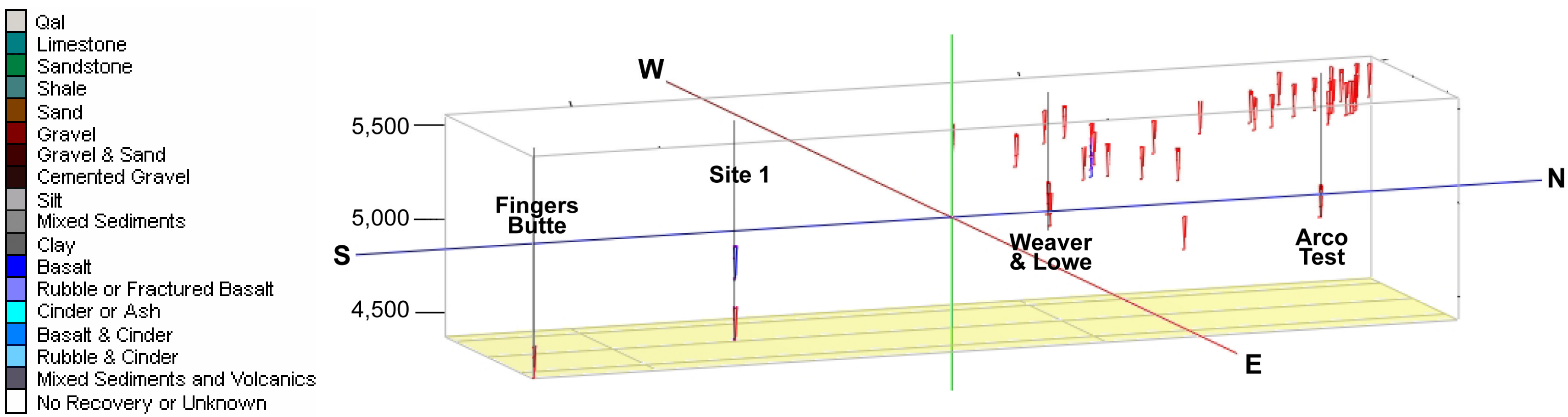

Figure 2-19d. Same as Figure 2-19c without lithology (water levels only).

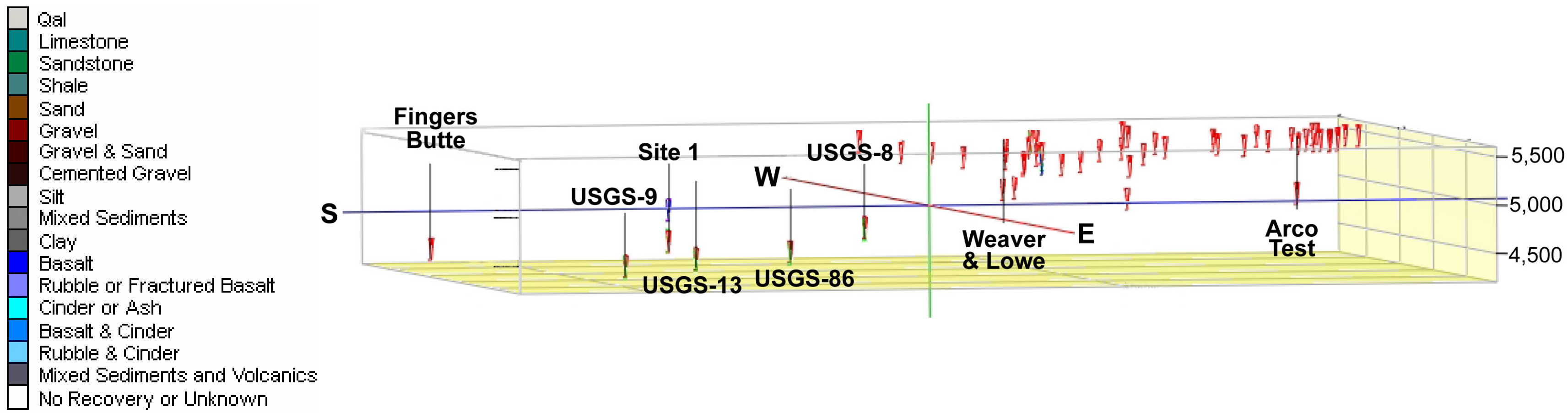

Figure 2-19e. A 1-to-15 scale, three-dimensional cross section of the Arco transition. This figure covers Townships 1N through 4N, Ranges 26E through 28E, from the town of Moore at the northwest corner of the cross section box to well USGS-009 in the south half of the INL Site at the southeast corner of the cross section box. The view is from the southeast at an azimuthal bearing of 105°, 5° above horizontal. This cross-sectional view is more than twice as wide as those shown is Figures 2-19a through 2-19d. All other cross section information is the same as that already described for Figure 2-19a. This figure shows the perched layer (blue) and water table (red) at Site 1 in the perspective of the southward deepening SRPA.

finer-grained sediments fanned outward from the mouth of the valley, forming an inland delta complex. The distance from the USGS's ARCO TEST monitoring well (Figure 2-18) to the inferred southern edge of these outwashed sediments is approximately 14.5 km (9 mi). The east-west extent of these sediments is approximately the same. This migration history of the Big Lost River is based on logs from more than 200 wells in the Arco area. Figures 2-19a through 2-19d represent an approximately north-south cross section through the middle of the outwashed sediment sequences using a small subset of these wells (the area of the cross sections is shown by the black rectangle in Figure 2-18).

Figures 2-19a and 2-19c show two different views of the three-dimensional, north-south cross section of the B&R to ESRP transition. At the beginning of the transition, many shallow water-bearing sands and gravels (shown in browns on Figures 2-19a and 2-19c) are interbedded with thick sequences of fine-grained sediments dominated by silts and clays (shown in grays). Static water levels (elongated red triangles) are initially shallow, but no wells penetrate to bedrock, so the existence of a deep basin-fill aquifer just north of the transition cannot be confirmed based on the data currently available.

Examining the strata at the ARCO TEST well (the first deep well on the right in Figures 2-19a and 2-19c), it is clear that a deep aquifer is present underneath the shallow water-bearing layers. These shallow sediments, both the channel deposits and the finer-grained ponded sediments, persist to the south far enough to be covered by the Holocene flows of the Craters of the Moon Lava Field. To the south, these sediments begin to pinch out and interbed with southward-thickening basalts.

Figures 2-19b and 2-19d show just the static water levels for the cross section. With the lithology omitted, the multi-layered nature of perched and deep aquifer layers is apparent. Our conceptual model for the path of the basin outflow is that the groundwater enters the transition zone traveling across multiple perched layers and works its way downward to the SRPA. Hydrostratigraphic evidence suggests that the deep water level measured in the ARCO TEST well represents the head in the SRPA. These data are not shown here due to space considerations but will be included in a future report dedicated to these aquifer transition zones.

The Site-1 well (02N26E22NESE), second to the left on Figures 2-19a and 2-19b, has a deep perched layer that appears to be potentially connected to the deep aquifer in the north half of the cross section. This is an artifact of the choice of wells picked for the cross section. Figure 2-19e shows a larger selection of static water levels in the environs of the Arco aquifer transition zone. By including the deep wells to the south and east of Arco, the southwesterly dip of the SRPA into the middle of the ESRP is apparent, as is the perched nature of the upper water level in the Site-1 well.

The groundwater transition between the Little Lost River tributary basin and the SRPA is similar in many ways to that of the Big Lost River, particularly with the pattern of interfingering basalts and fluvial sediments and also with the presence of multiple shallow and perched basin-fill aquifers feeding into the deeper SRPA across the width of the transition zone. The sink of the Little Lost River is in a subsiding basin. However, relative to the Lost River Range, Lemhi Range, and AVH, the amount of differential subsidence is small but sufficient to prevent the extensive ponding and lateral growth of the delta margin/lake margin sediments seen at Arco. While the intercalation, sediment types, and basalts are similar to those of Arco, the Little Lost River has not been entrapped and ponded by the rise of rift zones, so the transition between the basin fill aquifers and stratigraphy to that of the ESRP is less laterally extensive—no more than 4.8 km (3 mi) wide in a zone that stretches from the town of Howe to the northeast. The Howe transition does have one feature not seen at Arco, and that is the presence of the Lake Terreton and older pluvial sequences that approach and interfinger with transitional stratigraphy from the northeast.

The transition between the underflow in the Birch Creek drainage and the SRPA cannot be located with any certainty. Figures 2-20a and 2-20b show a three-dimensional cross section from Blue Dome in the northeast to TAN in the southwest. It is obvious from the figure that the bottoms of the Birch Creek Campground well (on the left) and the Boise State University (BSU) research well (in the middle of Figure 2-20b) are above the tops of the next nearest wells to the southeast at TAN. The distance between the BSU well and USGS-126A is approximately 9.5 km (6 mi), so the transition must occur in this interval. Compared to both the Big Lost and Little Lost transition areas, the Birch Creek transition is the simplest of the three, lacking both the entrapped and ponded sediment apron seen at Arco and the

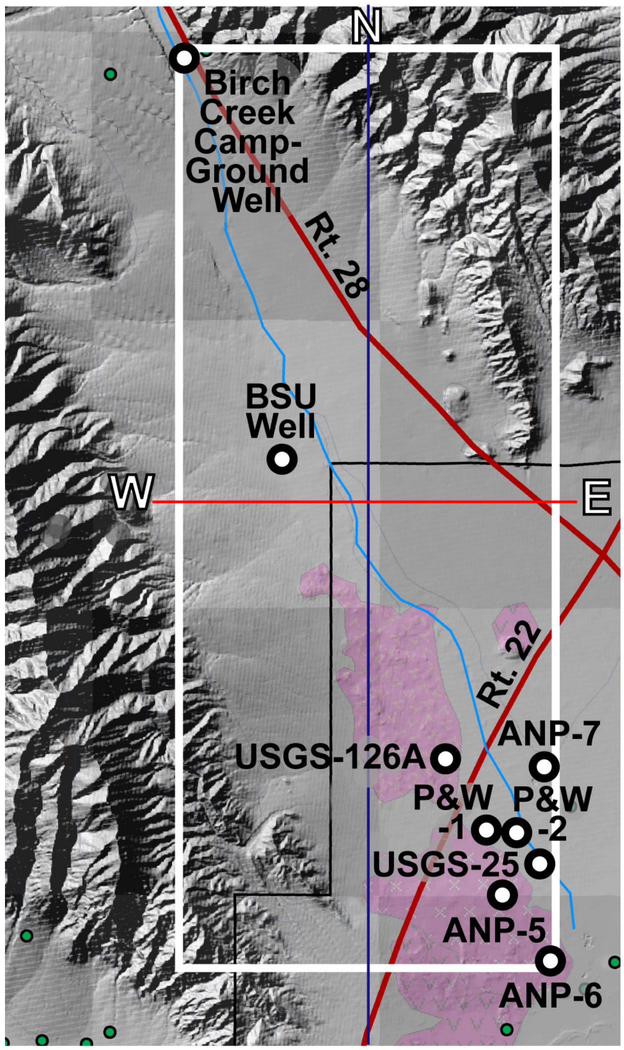

Figure 2-20a. Shaded relief map of Lower Birch Creek (light blue line) from the Bureau of Land Management Birch Creek Campground at Blue Dome to the northern portion of the INL Site just north of TAN. Major roads are in red. The black line is the north boundary of the INL Site. Green dots are water wells listed in the Idaho Department of Water Resources database. Large black-bordered white dots are water wells whose data were used to make the cross sections shown in Figure 2-20b. The pink areas are the exposed pahoehoe flows of the inactive Lava Ridge Rift Zone. The white box outlines the top of the cross section boxes shown in Figure 2-20b. The blue north-south and red east-west lines are the same as those shown in Figure 2-20b. The square areas of alternating grey shading are township-range blocks (each 6 mi to a side). The Birch Creek Campground well is in Block 9 North, 30 East. The BSU well is in Block 8 North, 30 East.

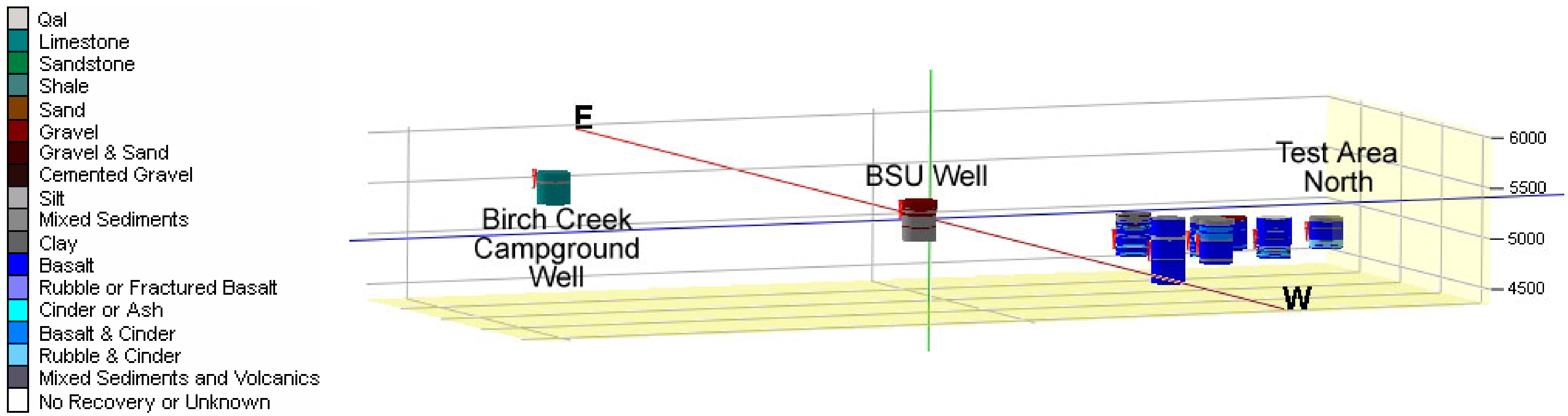

Figure 2-20b. Three-dimensional, 1-to-10 cross section of the Birch Creek transition zone viewed from the northwest. The area of the cross section box is the same as shown in Figure 2-20a. The lithography is the same as Figure 2-19. Static water levels are shown in red triangles. Elevations are in feet above mean sea level. The basalt dominated area in the south (right) half of the cross section is on the north and west side of TAN. The well to the north is at the U.S. Forest Service Birch Creek Campground at Blue Dome. The BSU research well in the center of the figure is at Township 8N, Range 30E, Section 15.

presence of interfingering pluvial beds at seen at Howe. Given the lack of any known complexity, we postulate that the Birch Creek transition will be similar in character to the other two transitions, with interfingering and with multiple shallow water layers eventually feeding into the SRPA through staggered perched zones; however, the width of the transition will be as short as or shorter than that seen at Howe.

2.2.3 Areal Recharge Derived from Direct Precipitation on the ESRP

The average precipitation over the OU 10-08 study area is approximately 20 cm (8 in.) per year. This precipitation occurs largely as winter snowfall, and most of this precipitation eventually returns to the atmosphere through evaporation and plant transpiration.

Most researchers concur that the distribution of recharge from direct precipitation is variable, depending on rock and soil type. Garabedian (1992) assumed that average annual recharge from infiltration of precipitation varied according to the amount of precipitation, the soil thickness, and the infiltration capacity of the soil cover. He distributed precipitation recharge throughout the ESRP by subdividing the area according to soil type and mean annual precipitation. Within the area encompassed by the OU 10-08 study area, Garabedian's estimated recharge for precipitation ranged from less than 1.27 cm (0.5 in.) to more than 5 cm (2 in.) per year. Larger recharge rates were associated with the Big Lost River floodplain in the vicinity of INTEC/RTC, the area of the Great Rift, and vicinity of East and Middle buttes near the southern corner of the INL Site. The State of Idaho Regional Water Resource Model utilized a similar distribution of recharge (Contor 2004). Both the Garabedian and the State of Idaho distributions of recharge from infiltration of precipitation are shown on Figure 2-21.

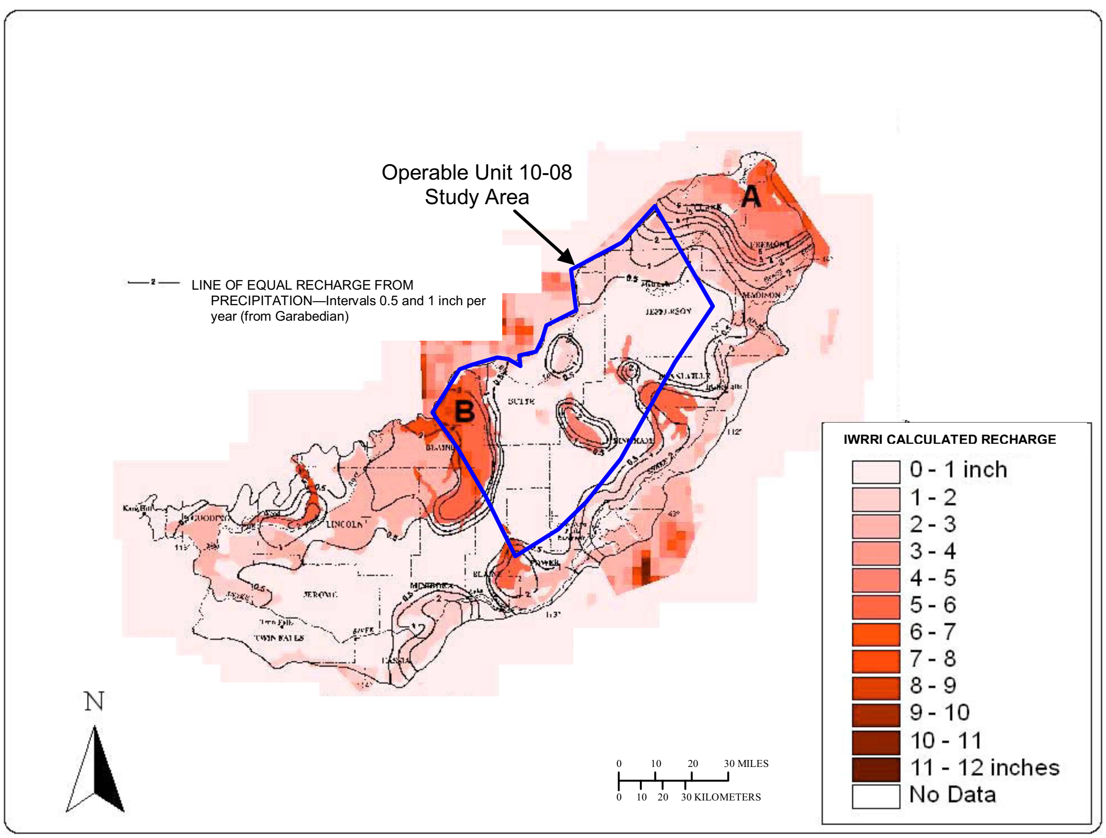

Figure 2-21. Estimates of recharge from infiltration of precipitation over the ESRP (Garabedian 1992; Contor 2004).

2.2.4 Regional Underflow out of the OU 10-08 Study Area

Regional underflow occurs across the southwestern boundary of the OU 10-08 study area. This underflow is part of the system of groundwater flow that eventually discharges to springs in the Thousand Springs area in the extreme southwestern part of the ESRP. No direct measurement of this underflow volume is possible. The estimate of underflow is derived from summation of the different inflows to the study area. Underflow out of the OU 10-08 study area ranges from 2,041 to 2,094 cfs (1,477,617 to 1,515,987 acre-ft/year), depending on the range of estimated recharge.

2.2.5 Other Sources of Inflow and Outflow

Within the OU 10-08 study area, other sources of inflow not considered in the overall water budget include recharge of applied irrigation water, possible flow upward from beneath the SRPA, and disposal of wastewater to INL Site facilities. Applied irrigation inflows occur in the Mud Lake area and contribute to the complexities of groundwater flow there. Evaluation of inflow from low-permeability rocks beneath the aquifer is not well defined and might not be essential to two-dimensional characterization of groundwater flow. The volume of wastewater disposal to INL Site facilities is minor in the context of the OU 10-08 study area.

Minor sources of outflow result from withdrawals from irrigation pumpage and from INL Site production well pumpage. Again, these sources are partially balanced by surface application of irrigation water and wastewater and are not considered in the overall water budget.

2.3 Groundwater Flow within the OU 10-08 Study Area

The following subsections discuss information pertinent to ascertaining flow directions and velocities in the SRPA within the OU 10-08 study area. This information is derived primarily from water-level data. Additionally, significant inferences about flow directions and velocity can be gained from geochemical data, including anthropogenic contaminant data and natural isotope tracer data. Lastly, temperature data, which are arguably the best data to infer flow velocities both in two- and three-dimensional interpretations, will be addressed.

2.3.1 OU 10-08 Study Area Water-level Data

Water-level data were used in the two-dimensional analysis of groundwater flow directions and velocities in the OU 10-08 study area. Water-level hydrographs showing historic trends in selected wells and water table maps from historic and recent water-level data that present the configuration of the water table at a given time were utilized in the analysis.

2.3.1.1 Long-term Water-level Trends. Historical water-level data have been collected from SRPA wells within the OU 10-08 study area for more than 50 years. More than 400 wells completed within the SRPA are routinely monitored for water levels. Most are measured by the USGS; approximately 200 are measured annually by Idaho Cleanup Project personnel.

Hydrographs were constructed for four selected wells (USGS-25, Site-14, Arbor Test, and USGS-9) to evaluate long-term trends in the configuration of the water table in the OU 10-08 study area (Figure 2-22). Water-level changes within these wells are typical of those for most of the other wells within the OU 10-08 study area. Water-level trends in all of these wells indicated a long-term decline in the elevation of the regional water table. This decline has been observed in all SRPA wells measured as part of the most recent INL sitewide water-level measurements. The decline in water levels during the past 50 years has averaged approximately 4.5 cm/year (0.15 ft/year), for a cumulative decline of approximately 2 m (7 ft). This long-term decline is attributed to increasing water consumption and reduction of recharge because of changes from flood irrigation to more efficient irrigation methods.

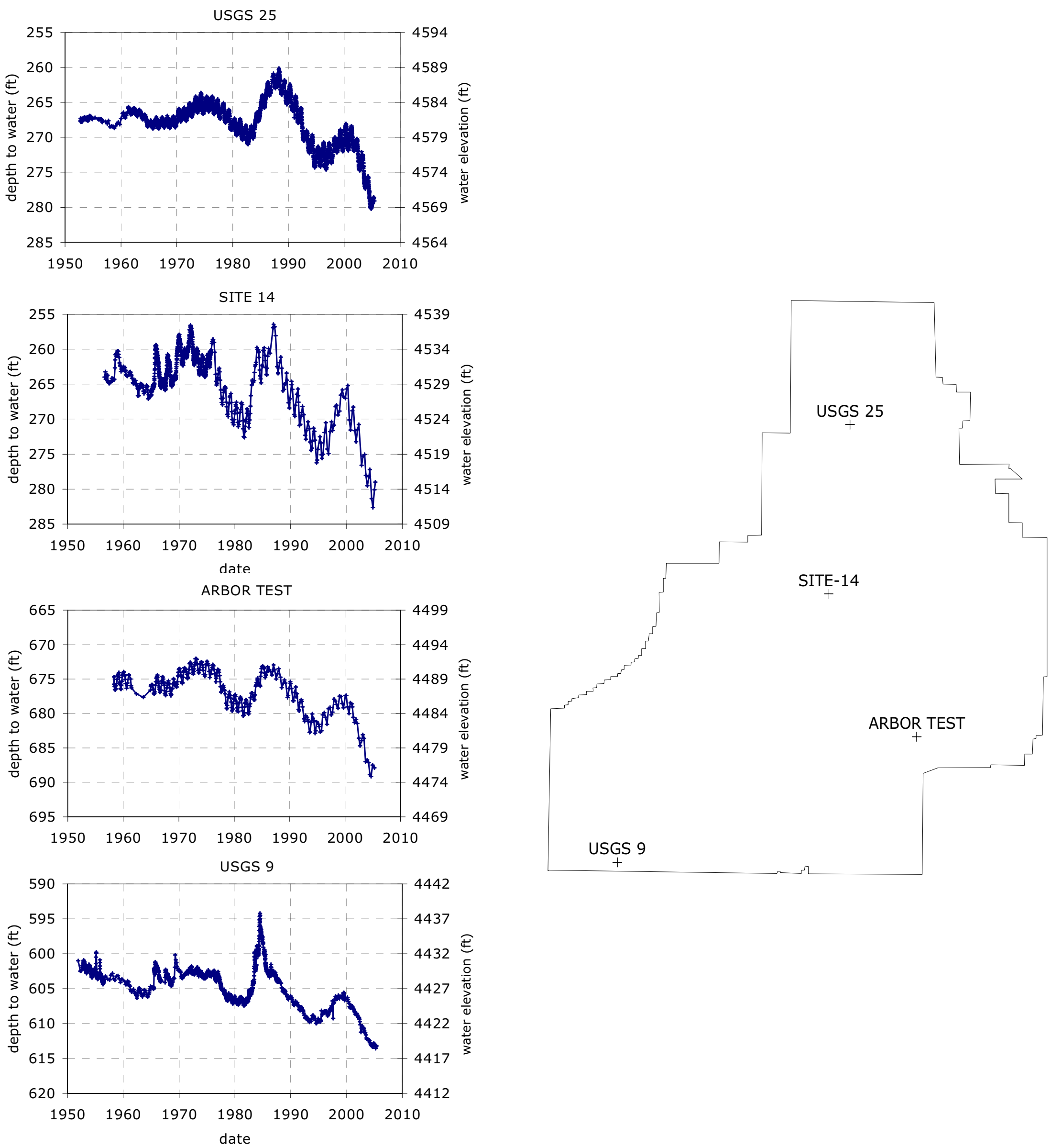

Figure 2-22. Water-level changes measured in wells USGS-25, Site-14, Arbor Test, and USGS-9 (1960 to present).

These hydrographs demonstrate intermediate-term declines and increases that correspond to drought/flood climatologic cycles (Figure 2-22). These cycles occur over an approximate interval of 10 years. Water-level fluctuations during these intervals can exceed 3 m (10 ft) or more in each direction. During the recent drought cycle, water levels within the OU 10-08 study area have declined at an average rate of about 0.6 m/year (2 ft/year).

These hydrographs also demonstrate seasonal fluctuations that are attributed to snowmelt recharge and irrigation pumping. Other observed fluctuations include those related to diurnal and synoptic barometric pressure changes and to pumping withdrawals from nearby INL Site production wells.

Hydrograph analyses were conducted to determine the recent stability of regional water-level changes. Water levels measured during a period of relatively small changes in the water table can be used to calibrate a steady-state numerical analysis. Conversely, water levels measured during a period of large water table fluctuation will not provide an accurate measure of the capability of a numerical tool to represent groundwater flow. The 1980 water table was relatively stable and provided water-level measurements that made calibration of the USGS regional groundwater flow model possible (Garabedian 1992). Most hydrographs show that water levels rose and peaked in about 1973 before declining for several years. Water levels generally remained stable for several years before and after 1980. Likewise, water levels rose again during the mid-1990s, peaking in 2000, and subsequently declining.

Based on these trends, the water table appears to be at the beginning of another relatively stable condition relative to long- and intermediate-term trends. Figure 2-23 shows detailed water-level changes in the Arbor Test well from 1960 to the present and demonstrates these periods of relatively stable water levels that occur at the bottom of intermediate drought cycles.

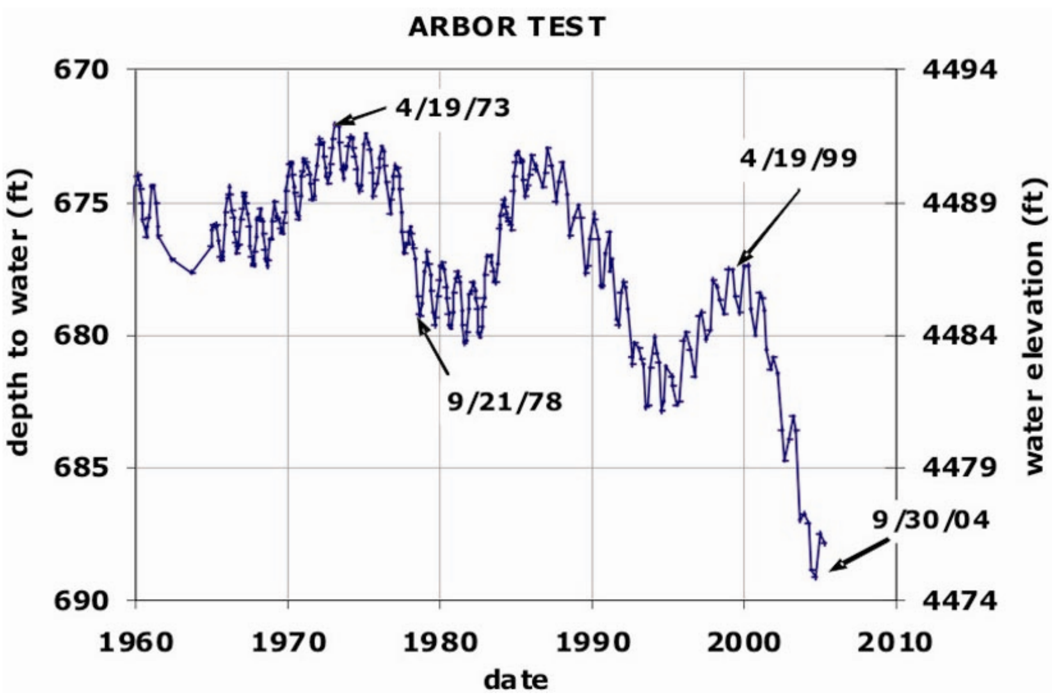

Figure 2-23. Water-level changes in the Arbor Test well (1960 to present).

2.3.1.2 Configuration of the Water Table. Mapping of the surface of the aquifer, or water table, provides an indication of the groundwater velocity or areas of contrasting permeabilities. Observed fluctuations in hydrographs, like those in Figure 2-22, have led researchers to prepare water table maps for different periods. Typically, such maps are prepared after mass water-level measurement campaigns, such those in June 2004 and 2005. The following paragraphs document preparation of the June 2004 water table for the OU 10-08 study area.

Historical Water Table Maps—Water table maps were prepared for 1980 and 1999, two periods of mass water-level measurements conducted by the USGS. The resulting USGS maps are at a regional aquifer scale and provide insufficient detail at the facility scale for the INL Site to support modeling and monitoring in these areas. As a result, the June 2004 water table map was prepared on a subregional scale with sufficient detail to incorporate both facility-scale behavior and the broader regional picture of groundwater movement.

Initial Version of the June 2004 Water Table Map—The June 2004 sitewide water-level measurements included 254 wells within the OU 10-08 study area (Figure 2-24). The data gathered from this campaign are stored electronically in the Environmental Data Warehouse database. These measurements are primarily from on-site wells or wells immediately south of the INL Site's southern boundary. Additional water-level data from wells distributed in the model domain but outside of INL Site boundaries were obtained from the National Water Information System (NWIS), a USGS Web-based database of well information and water levels.

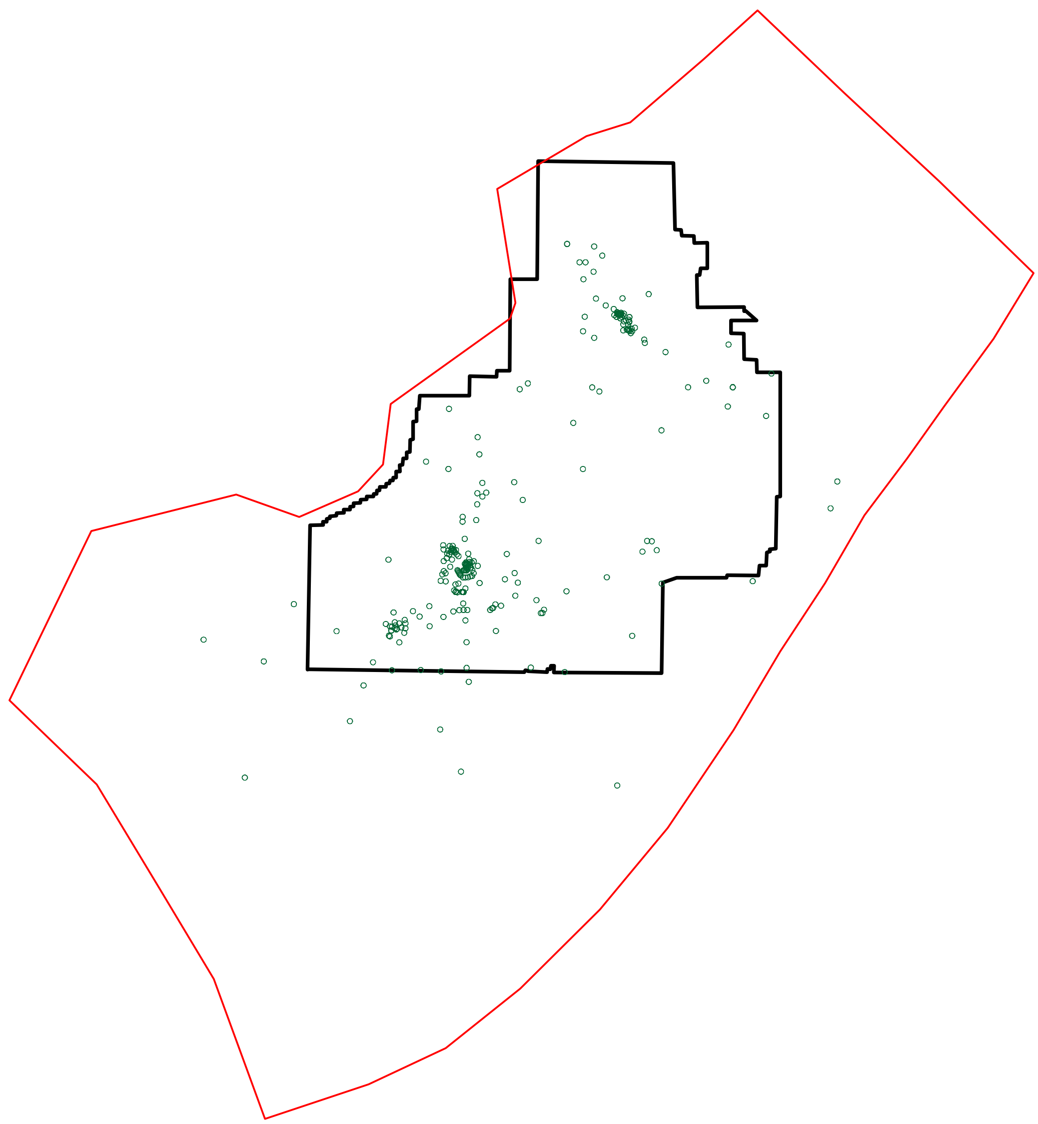

Figure 2-24. Location of wells used for the INL sitewide water-level measurement campaign (June 13 through 16, 2005).

The June 2004 measurement resulted in useable aquifer water-level measurements from 209 wells. Limitations in the spatial extent of this set required an additional collection activity in October 2004. Supplemental data were also gleaned from the NWIS database for well locations on the fringes of the OU 10-08 study area.

The initial version of the June 2004 water table map was based on water-level measurements from 282 wells (Figure 2-25). This water surface adequately supported the selection of model boundary locations and types based on the extent of the OU 10-08 study area. This version did not use the water-level measurement from well Site-2 (USGS site ID 431946113161401), because that water level appeared to be anomalously low. Deletion of that water level resulted in a linear alignment of water-level contours in the southwestern part of the study area. However, the map did not compare well with those prepared by other agencies after the 1980 and 1999 measurement campaigns, particularly in the southwest portion of the OU 10-08 study area.

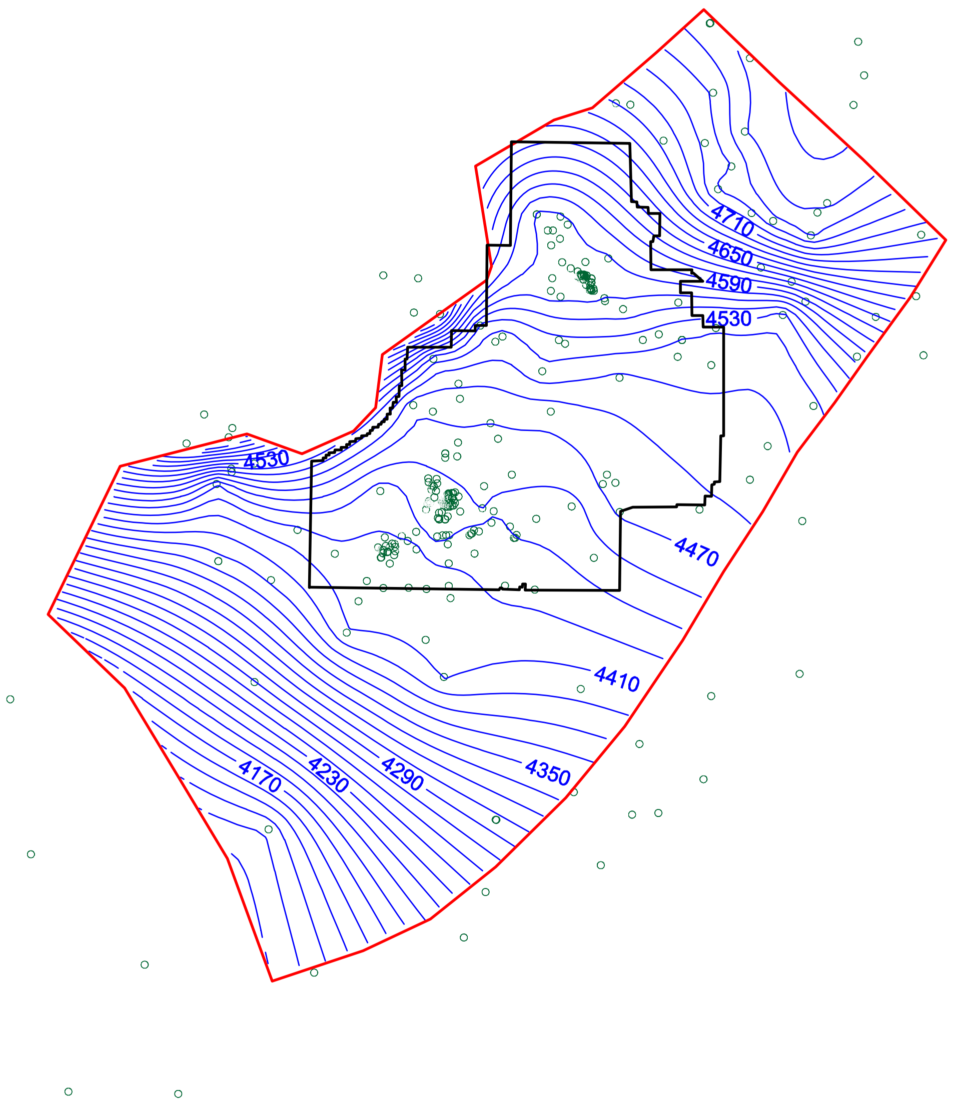

Figure 2-25. Initial cut on the June 2004 OU 10-08 water table map (elevation is feet above mean sea level, NGVD29; 15-ft contour intervals; green dots are locations of wells used in mapping).

Second Version of the June 2004 Water Table Map—A second map was constructed and included the water-level measurement from the Site-2 well (Figure 2-26). The inclusion of this point in the June 2004 map modified contours to be more consistent with 1980 and 1999 water table maps and the State of Idaho regional model simulation. Other available data, including land surface data, well locations, and water levels from prior periods, were examined in detail for the southwest portion of the study area to determine whether the single point causing the changes in contour shapes was an anomaly. The data point was found to be a valid one.

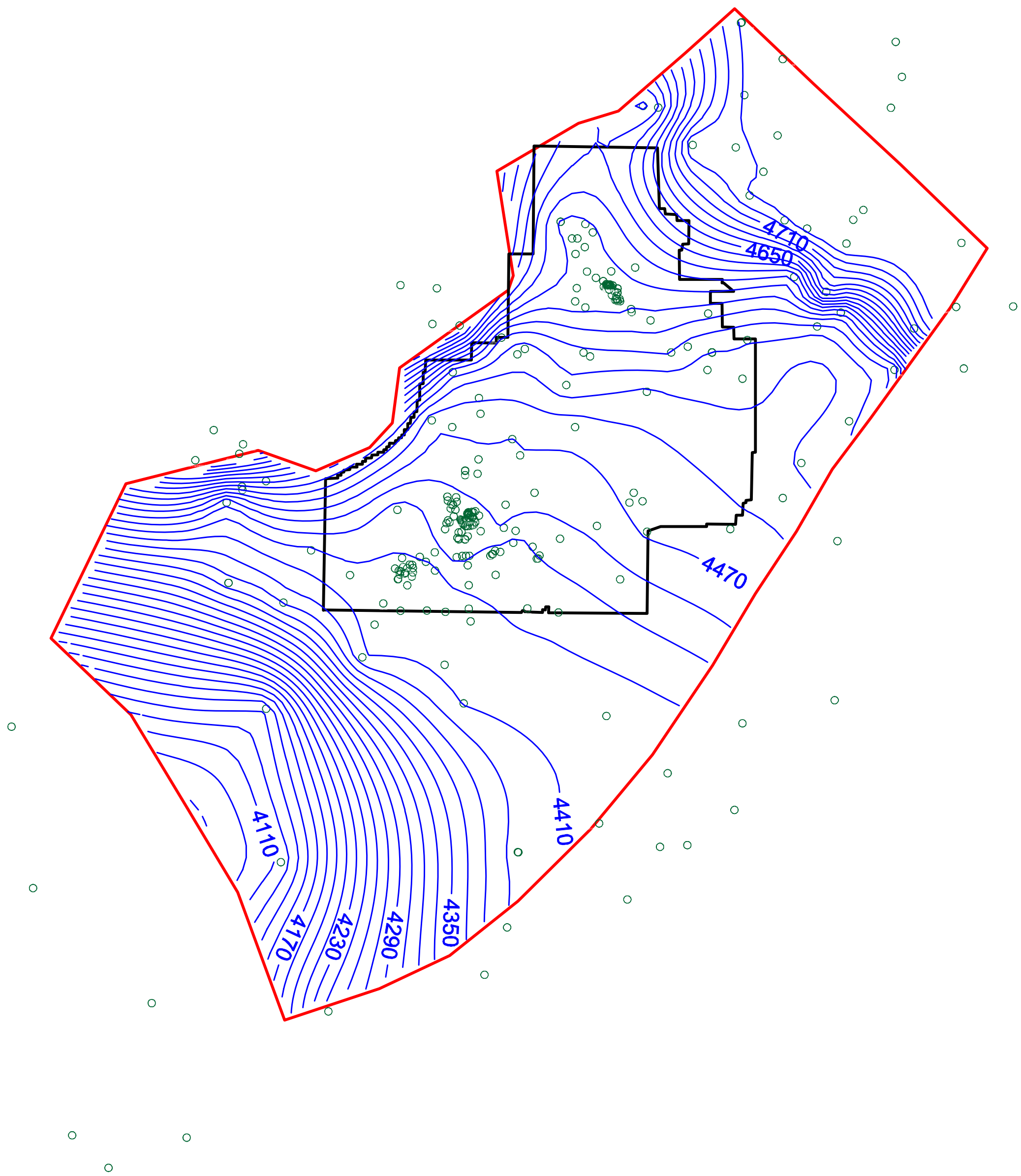

Figure 2-26. Second cut of the June 2004 OU 10-08 water-table map (elevation is feet above mean sea level, NGVD29; 15-ft contour intervals; green dots are locations of wells used in mapping).

A series of time- and space-interpolated water-level contour maps was prepared from historical water-level data. The map series was reviewed in an animated movie format to demonstrate the effects of this southwest area and the effects of short- and long-term hydrograph fluctuations on the direction and magnitude of groundwater flow. Streamlines were superimposed on these animations, as shown in Figure 2-27; the streamlines are tangential to flow directions and perpendicular at all times to contour lines of equal hydraulic head. From the animation, these streamlines were shown to exhibit a certain pattern of converging in the southwest portion of the study area and to move across the southeast boundary, which had been selected initially as a no-flow boundary corresponding to a flow path.

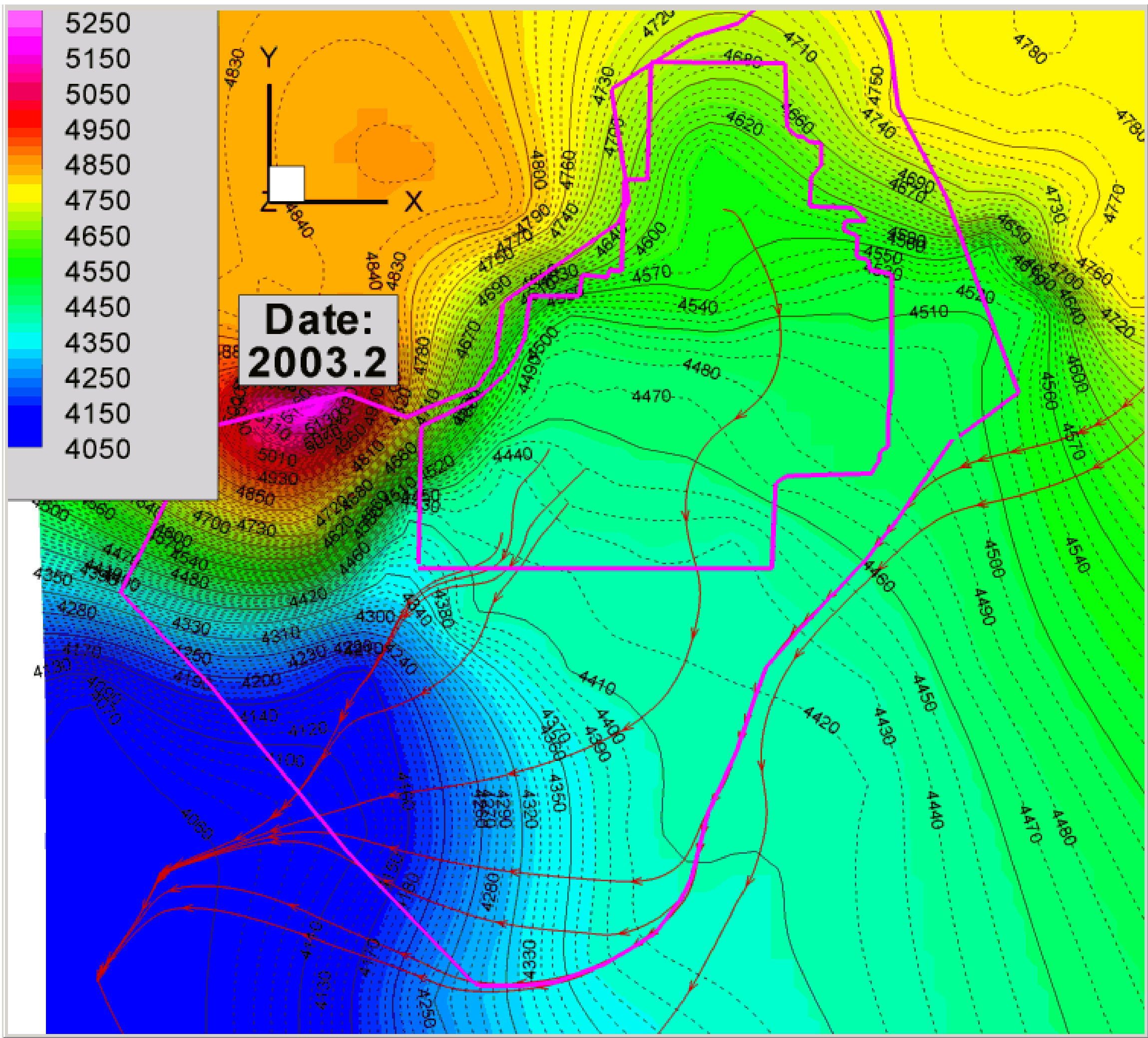

Figure 2-27. Water table map constructed from 2003 INL Site water-level data, with selected streamlines, including those emanating from major INL Site facilities. Contours are in units of feet above mean sea level.

Final Version of the June 2004 Water Table Map—From the animated water table movie, it was determined that the final model domain would likely not correspond exactly to the initial OU 10-08 study area. Further, extensive examination of all available well construction details and water table elevations in areas of the study domain near the Big Lost and Little Lost river valleys proved a layering effect occurring above the true regional aquifer in areas where significant underflow occurs at a lesser depth than the regional aquifer.

This effect is observed in six piezometer clusters in the Mud Lake vicinity near the northeast portion of the OU 10-08 study area. Initial model calibration showed the most difficulty matching heads was in this area. As a result, only the few wells from the Mud Lake area thought to be completed at depths representative of the regional aquifer were included in the final June 2004 water table contour map shown as Figure 2-28.

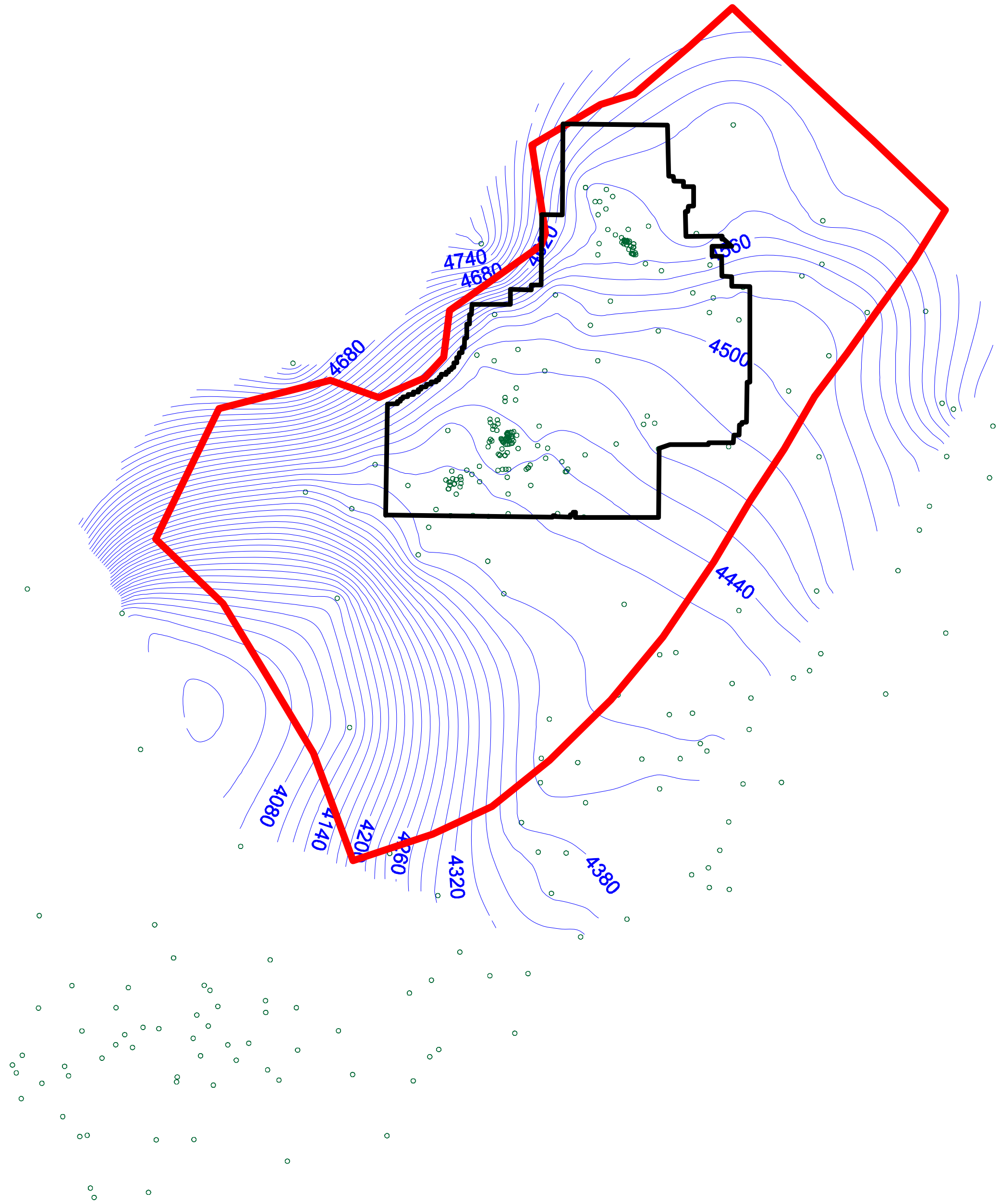

Figure 2-28. Final version of the June 2004 OU 10-08 water table map (elevation is feet above mean sea level, NGVD29; 15-ft contour intervals; green dots are locations of wells used in mapping).

The final map shown in Figure 2-28 supports the current interpretation of groundwater movement in the subregional area surrounding the INL Site. Streamlines show movement occurs generally in a southwest direction; groundwater enters the system from northeast of the OU 10-08 study area, with some appearing to enter directly from the east in the Henry’s Fork region of the Snake River. Water leaves the